

II. BIOLOGY OF COVERED SPECIES

A. Federally Listed Plant Species

1. *CASTILLEJA CAMPESTRIS* SSP. *SUCCULENTA* (FLESHY OWL'S-CLOVER)

a. Description and Taxonomy

Taxonomy.—Owl's-clovers are members of the figwort or snapdragon family (Scrophulariaceae). Hoover (1936a) first named fleshy owl's-clover, giving it the scientific name *Orthocarpus campestris* var. *succulentus*. The type specimen had been collected at Ryer, in Merced County. Hoover (1968) raised fleshy owl's-clover to the rank of species and assigned it the name *Orthocarpus succulentus*. Chuang and Heckard (1991) reconsidered the taxonomy of *Orthocarpus* and related genera. Based on floral morphology, seed morphology, and chromosome number, they transferred many species into the genus *Castilleja*. Furthermore, they determined that the appropriate rank for fleshy owl's-clover was as a subspecies of field owl's-clover (*Castilleja campestris*). Thus, the scientific name currently assigned to fleshy owl's-clover is *Castilleja campestris* ssp. *succulenta*, whereas field owl's-clover is *Castilleja campestris* ssp. *campestris* (Chuang and Heckard 1991). Another common name for fleshy owl's-clover is succulent owl's-clover (Skinner and Pavlik 1994).

Description and Identification.— *Castilleja campestris* ssp. *succulenta* (Figure II-1) has rather intricate flowers, with the corolla consisting of two lips. The flower has four sepals that are fused at the base, creating the calyx tube. Together, all the flowers plus the bracts comprise the inflorescence. The plant has erect or decumbent stems up to 30 centimeters (11.8 inches) long. The stems are usually unbranched and without hairs. The leaves at the base of the stem are small and scale-like, whereas those on the upper stem are 1.5 to 4 centimeters (0.6 to 1.6 inches) long, lance-shaped, not lobed, thick, fleshy, and easily broken. The bracts are green, similar to but shorter than the upper leaves, and longer than the flowers. Overall, the inflorescence may occupy as much as half of the plant's height and be 2 to 3 centimeters (0.8 to 1.2 inches) wide. *Castilleja campestris* ssp. *succulenta* has a diploid chromosome number of 24 (Chuang and Heckard 1993).

The brittle leaves are a key characteristic for identification of *Castilleja campestris* ssp. *succulenta*. The most similar taxon is *C. campestris* ssp. *campestris*. *Castilleja campestris* ssp. *campestris* has branched stems; thin, flexible, non-fleshy leaves; larger, lighter yellow flowers; a stigma that protrudes



Figure II-1. Illustration of *Castilleja campestris*. Reprinted with permission from Abrams (1951), *Illustrated Flora of the Pacific States: Washington, Oregon, and California*, Vol. III. © Stanford University Press.

beyond the upper lip of the flower; a lower anther sac that is no more than one-third the size of the upper; and more rounded seeds. *Castilleja campestris* ssp. *campestris* occurs farther north than *C. campestris* ssp. *succulenta* (Hoover 1937, Hoover 1968, Heckard 1977, California Department of Fish and Game 1986). Other *Castilleja* species have lobed leaves and bracts, and the bracts are often colored.

b. Historical and Current Distribution

Historical Distribution.—Between 1937 and 1986, *Castilleja campestris* ssp. *succulenta* was reported from 33 localities (Hoover 1937, Hoover 1968, California Natural Diversity Data Base 2005), all in the Southern Sierra Foothills Vernal Pool Region (Keeler-Wolf *et al.* 1998). Sixteen of those occurrences, including the type locality, were in eastern Merced County. Six occurrences each were in Fresno and Madera Counties and five others were in Stanislaus County (California Natural Diversity Data Base 2003) (**Figure II-2**).

Current Distribution.—Through August 2005, the California Natural Diversity Data Base (2005) had catalogued 91 occurrences of *Castilleja campestris* ssp. *succulenta* (catalogued as succulent owl's clover). About one-third of these occurrences are records from Merced County, catalogued in association with rare plant and wildlife surveys of eastern Merced County grass and ranch lands conducted during 2001 by a team of consultants to the County and California Department of Fish and Game (Vollmar 2002).

Of the 91 total data base occurrences, 90 are presumed to be extant, lacking any evidence to the contrary. One occurrence in Fresno County is considered to be “possibly extirpated” (California Natural Diversity Data Base 2005) because the site had been disced when it was last visited in 1981. Another unreported (to the data base) site in Fresno County may also be extirpated (J. Stebbins *in litt.* 2000a). Currently, among the 91 reported occurrences, 70 percent are in Merced County, 12 percent are in Fresno County, 10 percent are in Madera County, 5 percent are in Stanislaus County, and 1 percent is in San Joaquin County (M. Trask *in litt.* 1993, EIP Associates 1994, C. Witham *in litt.* 2000b, California Natural Diversity Data Base 2003). All but one of these occurrences are in the Southern Sierra Foothills Vernal Pool Region; one San Joaquin County site is in the Southeastern Sacramento Valley Vernal Pool Region (Keeler-Wolf *et al.* 1998).

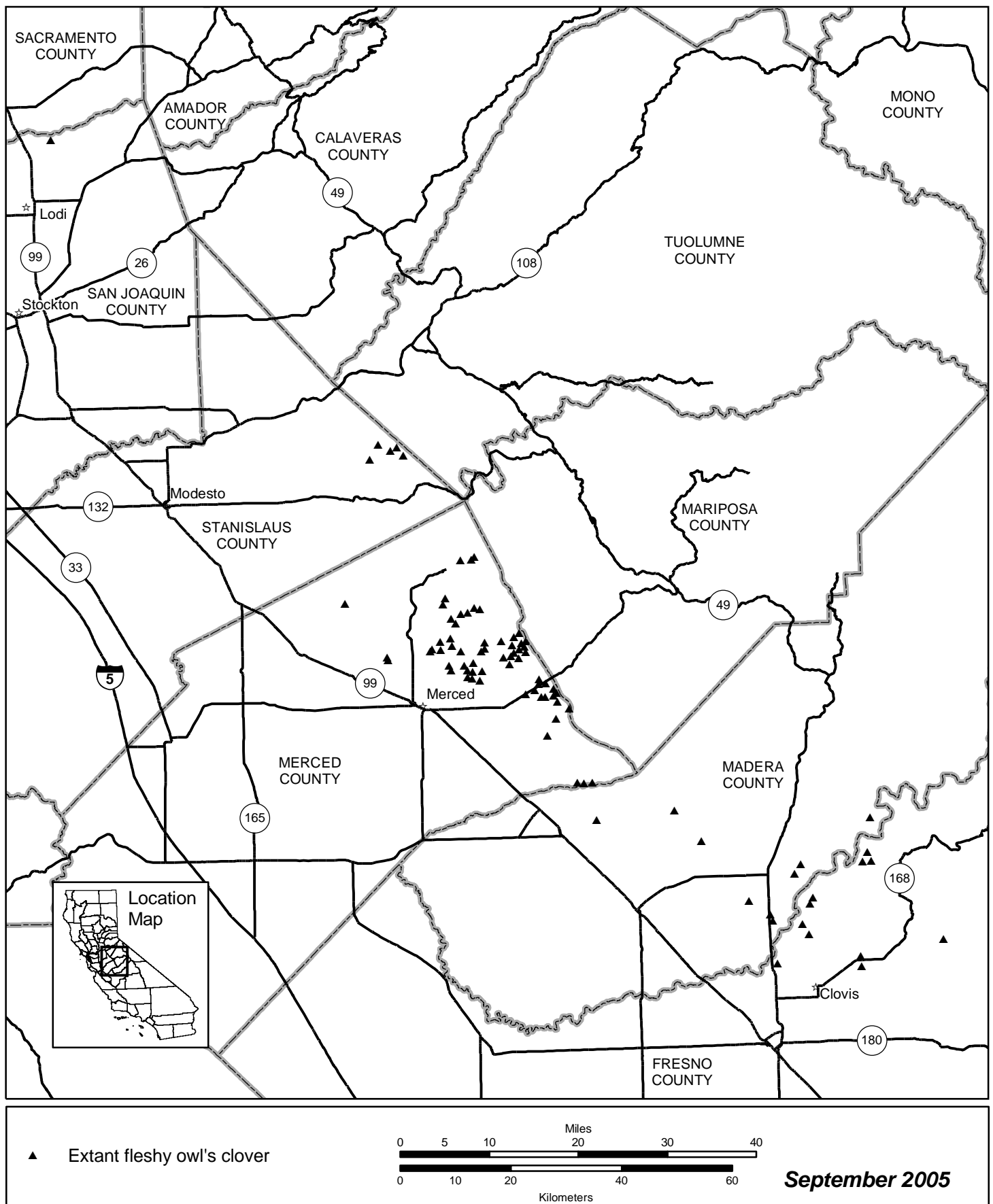


Figure II-2. Distribution of *Castilleja campestris* ssp. *succulenta* (fleshy owl's-clover).

This information, and especially the recent records, confirm that the primary area of concentration for *Castilleja campestris* ssp. *succulenta* is in eastern Merced County, especially just northeast of the City of Merced. In particular, many of the known occurrences are between La Paloma Road and Highway 140, east of Yosemite Lake. In addition to the proposed University of California campus area and related community, this area includes the Flying M Ranch and other ranch land. In addition, *C. campestris* ssp. *succulenta* was found in 296 vernal pools in the proposed campus and community area during recent surveys of 34 percent of that area (EIP Associates 1999). A later study of vernal pool habitat in the campus lands area, using a different reporting format that is not directly comparable, nevertheless also found *C. campestris* ssp. *succulenta* at significant levels (3 to 6 percent of the habitat area) (Jones and Stokes 2003). Moreover, Vollmar (2002) concluded that this listed plant is likely to be found throughout much of the range land portion of the eastern Merced County survey area, wherever there are better-developed, dense, interconnected vernal pools, and that this study area clearly represents a very important geographical region for the conservation of *C. campestris* ssp. *succulenta*.

Other occurrences in Merced County are somewhat farther to the north and south. In addition, a secondary area of concentration is located in southern Madera County and northern Fresno County, from just west of Highway 41 east to Academy and north to Miller's Corner, with 17 occurrences. Also, two smaller areas of concentration, which include five occurrences each but contain large numbers of plants, are near Cooperstown in Stanislaus County and the "tabletop" mountains near Millerton Lake in Fresno and Madera Counties. Other more scattered occurrences include two at Castle Airport northwest of Merced, one near Wildcat Mountain in Fresno County, and one in San Joaquin County. Significant areas of suitable habitat remain unsurveyed, particularly in northern Merced County (EIP Associates 1999) and between the northern Stanislaus County and northern San Joaquin County sites (J. Stebbins *in litt.* 2000b). Thus, additional occurrences are likely to be found if further surveys similar to those reported by Vollmar (2002) are conducted.

c. Life History and Habitat

Reproduction and Demography.—*Castilleja campestris* ssp. *succulenta* is an annual plant. As with many related species, it is a hemiparasite, meaning that it obtains water and nutrients by forming root grafts with other host plants but manufactures its own food through photosynthesis (Chuang and Heckard 1991). Research on hemiparasitism has focused on related species of *Castilleja*, but not specifically on *C. campestris* ssp. *succulenta*. Many different plants can serve as hosts for a single species or even a single individual of *Castilleja*. Seeds of *Castilleja* species do not require the presence of a host to germinate, and form

root connections only after reaching the seedling stage. Some seedlings can survive to maturity without attaching to a host's roots, but in general reproduction is enhanced by root connections (Atsatt and Strong 1970).

The conditions necessary for germination of *Castilleja campestris* ssp. *succulenta* seeds have not been studied, nor has the timing of seed germination been documented. Flowering occurs in April and May (Skinner and Pavlik 1994). The importance of pollinating insects is not known for certain. Some aspects of *C. campestris* ssp. *succulenta* biology suggest that it may be self-pollinating (Heckard 1977), but many related taxa of *Castilleja* are pollinated by generalist bees (Superfamily Apoidea) (Chuang and Heckard 1991).

Among close relatives that do not require insect pollinators, flower structure and timing of stigma receptivity maximize the chances for self-fertilization and seed set. Even so, insects may transfer some pollen among individual plants and species occurring in the same area. Self-pollinating species of *Castilleja* typically occur as widely scattered individuals, rather than in dense colonies (Atsatt 1970). *Castilleja campestris* ssp. *succulenta* follows this pattern in part, often occurring in many pools within a complex but with fewer than 100 plants per pool. However, *C. campestris* ssp. *succulenta* also may occur in large populations within a single pool (California Natural Diversity Data Base 2003). Little is known about the demography of *C. campestris* ssp. *succulenta*, although population size can fluctuate greatly from year to year. In the few populations where population size was reported for more than 1 year, fluctuations up to two orders of magnitude were noted (California Natural Diversity Data Base 2003).

Habitat and Community Associations.—*Castilleja campestris* ssp. *succulenta* occurs in Northern Claypan and Northern Hardpan vernal pools (Sawyer and Keeler-Wolf 1995) within annual grassland communities (California Natural Diversity Data Base 2003). The plant is known from both small and large pools (EIP Associates 1999, J. Stebbins *in litt.* 2000a). Although not all pools occupied by this taxon have been studied in detail, Stebbins *et al.* (1995) collected data on six occupied pools in Fresno and Madera Counties. Some were typical “bowl-like” pools, whereas others were more similar to swales. Approximate pool area ranged from 0.03 to 0.65 hectare (0.07 to 1.61 acres), depth from 30 to 38 centimeters (11.8 to 15.0 inches), and pH of the soil underlying the pools from 5.00 to 6.24 (Stebbins *et al.* 1995). This subspecies has been reported from pools with both long and short inundation periods (EIP Associates 1999) and from both shallow and “abnormally deep” vernal pools, but approximate depth of these pools was not given (California Natural Diversity Data Base 2003).

The soil types have not been determined for all of the sites where *Castilleja campestris* ssp. *succulenta* occurs. At the one site in the Southeastern Sacramento

Valley Vernal Pool Region, the soil is San Joaquin sandy loam. Soil series supporting *C. campestris* ssp. *succulenta* in the Southern Sierra Foothills Vernal Pool Region include Amador, Anderson, Corning, Fallbrook, Hideaway, Keyes, Pentz, Ramona, Redding, San Joaquin, Vista, and Yokohl, as well as the Pollasky-Montpellier complex. Soil textures at those sites range from extremely stony loam to loamy clay. In the proposed University of California-Merced campus and community area, 81.4 percent of the individual pools where this taxon was found were on Redding gravelly loam, 9.5 percent were on Corning gravelly sandy loam, 6.4 percent were on Corning gravelly loam, 1.7 percent were on Keyes gravelly loam, 0.7 percent were on Keyes gravelly clay loam, and 0.3 percent were on Pentz loam (EIP Associates 1999).

Populations of *Castilleja campestris* ssp. *succulenta* have been reported from elevations of 24 meters (80 feet) at the San Joaquin County site to 700 meters (2,300 feet) at Kennedy Table in Madera County (California Natural Diversity Data Base 2003). Plants most commonly reported as occurring with *C. campestris* ssp. *succulenta* are *Lasthenia fremontii* (Fremont's goldfields) (EIP Associates 1999), *Downingia* spp. (downingia), *Mimulus tricolor* (three-colored monkey-flower), *Plagiobothrys stipitatus* (vernal pool popcorn flower), and *Eryngium* spp. (coyote-thistle) (California Natural Diversity Data Base 2005). Other plants featured in this recovery plan that have been reported growing with *C. campestris* ssp. *succulenta* are: *Neostapfia colusana*, *Orcuttia inaequalis*, *O. pilosa*, *Gratiola heterosepala* (EIP Associates 1999, California Natural Diversity Data Base 2005), and *Eryngium spinosepalum* (EIP Associates 1994).

d. Reasons for Decline and Threats to Survival

Most species addressed in this recovery plan are threatened by similar factors because they occupy the same vernal pool ecosystems. These general threats, faced by all the covered species, are discussed in greater detail in the Introduction section of this recovery plan. Additional, specific threats to *Castilleja campestris* ssp. *succulenta* are described below.

One significant specific threat is the proposed construction of the new University of California campus in Merced County. This project, plus associated residential development and access roads, are threats to the primary and relatively extensive population in that area. Of the 12 occurrences recorded in the California Natural Diversity Data Base on the proposed campus and associated community, 4 are in the area that is expected to be developed within the next 15 years; these 4 occurrences include 226 of the 296 occupied pools (76 percent) in the University planning area (EIP Associates 1999). Additional urban developments that threaten many other known occurrences include planned housing subdivisions in Fresno, Madera, and San Joaquin Counties; a freeway expansion in Madera

County; and a proposed landfill in Fresno County (U.S. Fish and Wildlife Service 1997a, J. Stebbins *in litt.* 2000b, California Natural Diversity Data Base 2003).

Exclusion of grazing from sites that have been grazed historically may increase the threat of competition with nonnative plants. About two-thirds of the reported occurrences of the species, including those at the University of California-Merced site, were subject to cattle grazing when first discovered (EIP Associates 1999, California Natural Diversity Data Base 2003). Grazing should be monitored, and adjusted as needed, to maintain and enhance the species. Grazing may not be appropriate for all populations. Consideration of the possible negative effects to *Castilleja campestris* ssp. *succulenta* should be given before grazing is introduced into a population that has not been previously grazed.

Threats due to alterations in natural hydrology include the Merced County Stream Channel Project proposed by the U.S. Army Corps of Engineers (U.S. Fish and Wildlife Service 1997a) and proposed enlargement of Burns Reservoir in Merced County (California Natural Diversity Data Base 2003), which collectively threaten seven occurrences of *Castilleja campestris* ssp. *succulenta*. Expansion of agricultural operations threatens three occurrences in Fresno and Madera Counties that are surrounded by orchards, vineyards, or citrus groves (California Natural Diversity Data Base 2003). A proposed gravel mine threatens one occurrence of *C. campestris* ssp. *succulenta* in Fresno County. Two other occurrences, at the former Castle Air Force Base in Merced County, are threatened by excavation to remove soil that was contaminated by lead from skeet shooting (California Natural Diversity Data Base 2003).

Threats posed by small population size may also be a significant continuing factor because small size makes populations more vulnerable to extirpation from chance events. Among the 24 populations of *Castilleja campestris* ssp. *succulenta* for which size estimates have been documented, 10 consisted of fewer than 100 plants each at their peak size (J. Stebbins *in litt.* 2000b, California Natural Diversity Data Base 2003).

e. Conservation Efforts

We listed *Castilleja campestris* ssp. *succulenta* as threatened on March 26, 1997 (U.S. Fish and Wildlife Service 1997a). This taxon has been State-listed as endangered since 1979 (California Department of Fish and Game 1991). The California Native Plant Society considered it to be rare and endangered 5 years earlier (Powell 1974) and still includes *C. campestris* ssp. *succulenta* on its List 1B, noting that it is “endangered in a portion of its range” (California Native Plant Society 2003). In 2005, critical habitat was designated for *C. campestris* ssp. *succulenta* and several other vernal pool species in *Final Designation of Critical*

Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon; Evaluation of Economic Exclusions From August 2003 Final Designation; Final Rule (U.S. Fish and Wildlife Service 2005).

Three populations of *Castilleja campestris* ssp. *succulenta* fall primarily within designated reserves, on two “tabletop” mountains near Millerton Lake in Fresno County. The Sierra Foothill Conservancy’s Big Table Mountain Preserve includes all of one population. The second population is shared between the preserve and the adjacent U.S. Bureau of Land Management property. The third population is within the California Department of Fish and Game’s Big Table Mountain Preserve. A cooperative group consisting of the California Department of Fish and Game, California Department of Parks and Recreation, Sierra Foothill Conservancy, U.S. Bureau of Land Management, and U.S. Bureau of Reclamation is developing a management and monitoring plan for Big Table Mountain. Initial efforts include a study on grazing as a means to control nonnative grasses while comparing population trends of threatened and endangered species in grazed and ungrazed portions of the tableland (M. Griggs *in litt.* 2000, J. Darren, BLM, *in litt.*, 2005).

A fourth population is found on a nearby tabletop, occurring partly on U.S. Bureau of Land Management land and partly on privately-owned land. Previously the site was seriously overgrazed, leading the U.S. Bureau of Land Management to erect fences to exclude cattle from the tabletop, with variable success (A. Franklin *in litt.* 1993). The management and monitoring plan for the other nearby tabletop vernal pools could be easily modified to include this fourth population.

At least seven occurrences of *Castilleja campestris* ssp. *succulenta* on the Flying M Ranch in Merced County are protected from development by a conservation easement negotiated between the landowner and The Nature Conservancy (U.S. Fish and Wildlife Service 1997a). Several other occurrences are in public ownership but are not necessarily protected from development, nor are they managed for the benefit of this or other vernal pool taxa. These occurrences include (1) the extensive populations on the proposed University of California campus in Merced County, (2) a large population on property acquired by the California Department of Transportation for mitigation purposes in Madera County (Stebbins *et al.* 1995, California Natural Diversity Data Base 2003), (3) two small populations on Castle Airport, formerly Castle Air Force Base, in Merced County (California Natural Diversity Data Base 2003), (4) a small population on U.S. Bureau of Reclamation property that is managed by the

Madera Irrigation District (Stebbins *et al.* 1995, California Natural Diversity Data Base 2003), and (5) the small population in San Joaquin County that is on land used for educational purposes by the University of California Cooperative Extension (California Natural Diversity Data Base 2003).

2. *CHAMAESYCE HOOVERI* (HOOVER'S SPURGE)

a. Description and Taxonomy

Taxonomy.—Hoover's spurge is a member of the spurge family (Euphorbiaceae). This plant was originally named *Euphorbia hooveri*, based on a specimen collected by Hoover in Yettam, Tulare County (Wheeler 1940). At that time, the genus *Euphorbia* was viewed as comprising several subgenera, including *Chamaesyce* and *Euphorbia*. Webster (1975) subsequently elevated the subgenus *Chamaesyce* to the rank of genus based on growth patterns and physiology. The currently accepted scientific name, *Chamaesyce hooveri*, was validated when Koutnik (1985) published the new combination.

Several other species of *Chamaesyce* have ranges similar to that of *Chamaesyce hooveri* and may occur in the same habitats. *Chamaesyce ocellata* ssp. *ocellata* (yerba golondrina) is yellowish-green, has untoothed leaves, and lacks appendages on the glands. *Chamaesyce ocellata* ssp. *rattanii* (Stony Creek spurge) has hairy stems and leaves and the gland appendages are entire. *Chamaesyce serpyllifolia* (thyme-leaved spurge) also has entire appendages and further differs from *C. hooveri* in microscopic characters of the female flower (Wheeler 1941, Munz and Keck 1959, Koutnik 1993).

Description and Identification.—*Chamaesyce hooveri* (**Figure II-3**) trails along the ground, forming gray-green mats 5 to 100 centimeters (2.0 to 39.4 inches) in diameter (Broyles 1987, Stone *et al.* 1988). The stems are hairless and contain milky sap. The tiny (2 to 5 millimeter [0.08 to 0.20 inch]) leaves are opposite, rounded to kidney-shaped, with an asymmetric base and a toothed margin. In the genus *Chamaesyce*, the structures that appear to be flowers actually are groups of flowers; each group is referred to as a cyathium. The cyathium in *C. hooveri* consists of a tiny, cup-like structure 2 millimeters (0.08 inch) in diameter containing five clusters of male flowers and a single female flower. None of the flowers have petals, but instead have white appendages on the edge of the cup that resemble petals. Each appendage is divided into from three to five finger-like projections about 1 millimeter (0.04 inch) long. The appendages are attached to four reddish glands situated along the margin of the cup. The tiny, white seeds are contained in a spherical capsule 2 millimeters (0.08 inch) in